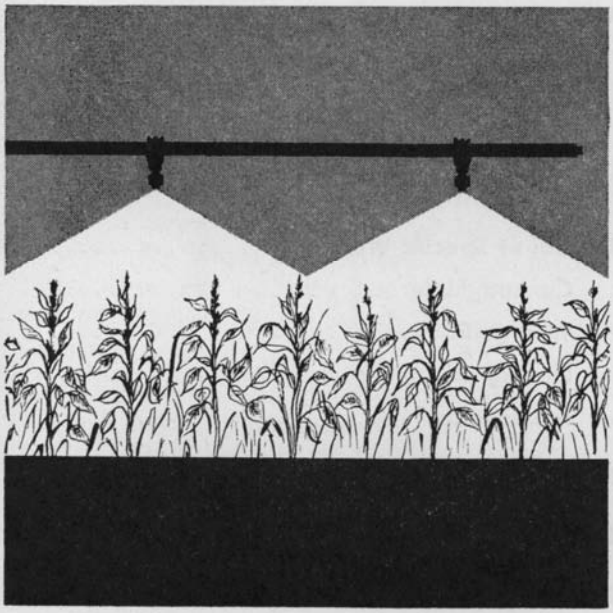
CHEMICAL CONTROL of WEEDS and BRUSH



CIRCULAR 771 • EXTENSION SERVICE IN AGRICULTURE AND HOME ECONOMICS • UNIVERSITY OF ILLINOIS • COLLEGE OF AGRICULTURE

CONTENTS

This circular supersedes Circular 742 with the same title.

Urbana, Illinois April, 1957

Cooperative Extension Work in Agriculture and Home Economics: University of Illinois, College of Agriculture, and the United States Department of Agriculture cooperating. Louis B. Howard, *Director*. Acts approved by Congress May 8 and June 30, 1914.

CHEMICAL CONTROL OF WEEDS AND BRUSH

By E. C. Spurrier, W. O. Scott, and F. W. Slife[1]

THAT WEEDS CAUSE TREMENDOUS LOSSES in agriculture is, of course, well known. The damage is only too obvious when a weed infestation becomes severe or when weed parts show up in harvested grain or forage.

But long before the damage reaches this state, weeds have been taking their toll. Every weed in a crop field competes with the crops for light, water, and mineral nutrients. According to the U. S. Department of Agriculture, one plant of common yellow mustard requires twice as much nitrogen, twice as much phosphoric acid, four times as much potash, and four times as much water as a well-developed oat plant. Common ragweed has a water requirement three times that of corn. Weeds not only damage crops directly, but they also harbor insects and diseases that attack crop plants.

To control weeds effectively a combination of practices is necessary. One important weapon is found in the new chemical weedkillers, or herbicides, which are discussed in this circular. It must be remembered, however, that they are only a supplement to good farming methods. In the control of weeds there is no substitute for these conditions and practices:

1. Crop seed that is free from weed seed.
2. A good crop rotation.
3. High soil fertility.
4. Good cultivation and good seedbed preparation.
5. Practices that will prevent weeds from maturing viable seed.

Types of Herbicides

Herbicides (chemical weedkillers) are divided into two major groups: nonselective, which kill all vegetation in the treated area; and selective, which kill certain plants but do not injure others.

Nonselective herbicides

Sodium chlorate, borax, and boron-chlorate combinations have been used for many years to control certain perennial noxious weeds.

[1] E. C. Spurrier, Assistant Professor of Agronomy; W. O. Scott, Associate Professor of Crop Extension; and F. W. Slife, Assistant Professor of Crop Production.

They have proved to be valuable herbicides, with relatively long-lasting effects. When applied at rates heavy enough to kill weeds, however, they also kill or depress all other vegetation for one or more years, the duration of the effect depending partially on the rate of application. Therefore they are not suggested for controlling weeds in crops, except on a spot-treatment basis.

There are many newer nonselective herbicides that may also be effective in a weed-control program. Here are just a few of those chemicals.

Atlacide (a preparation of sodium chlorate) or sodium chlorate is recommended for controlling Johnsongrass, quackgrass, leafy spurge, hoary cress, Canada thistle, and perennial sowthistle where soil sterilization for one or more years is not objectionable. This chemical can also be used in crops to control single weeds or small patches of weeds.

The usual rate for sodium chlorate is 5 pounds per square rod during the growing season or 3 pounds in late October and early November. Atlacide should be used at a slightly higher rate — probably 6 to 7 pounds per square rod during the growing season and 4 to 5 pounds in the late fall. These materials can be applied either dry or as a spray.

Clothing and foliage that have been wet with a spray of sodium chlorate and then dried are highly flammable. Atlacide has a similar effect, but to a lesser degree.

Borax compounds are not flammable and can be used safely around warehouses and grain elevators to control noxious weeds. When applied at rates high enough to kill weeds, however, these compounds sterilize the soil for relatively long periods of time. The usual rate of application is 15 to 25 pounds per square rod.

Boron-chlorate combinations also sterilize the soil. Only 5 to 9 pounds should be applied per square rod.

Ammate (ammonium sulfamate) may be used as a woody-plant killer. It kills all vegetation but does not sterilize the soil for as long as sodium chlorate and borax do. Apply Ammate as a spray at the rate of 1 pound per gallon of water. Immediately after spraying, wash the spray equipment to reduce corrosion.

Dowpon when applied at low rates — 6 to 10 pounds per acre — is a grass-selective herbicide, but at heavier rates — 20 to 30 pounds per acre — it acts as a temporary soil sterilant.

Amino triazole is a nonpoisonous, water-soluble systemic com-

pound that destroys the chlorophyl in green plants. It is toxic to crops and at present should be used only to spot-treat specific weeds in non-crop areas.

Monuron, Diuron, and Fenuron are just three of a new group of urea compounds which are nonselective at relatively high rates of application. They are not as effective as several other soil-sterilizing compounds for some deep-rooted perennial weeds since they move very slowly through the soil. Monuron may be valuable in controlling weeds on railroad right of ways and other areas where soil sterilization is desirable.

These compounds are formulated as liquids or wettable powders and are only slightly soluble in water. They should not be allowed to be carried by drainage water into cropland where crops may be damaged.

Dinitro and TCA, along with several other nonselective herbicides, are discussed later under specific weed problems.

Selective herbicides

The most popular selective herbicides now in use in Illinois are 2,4-D, MCP, and 2,4,5-T. All three are nonpoisonous, noncorrosive, relatively cheap, and easy to apply. Under most conditions, they will kill certain species of plants and leave others undamaged.

2,4-D herbicides are usually formulated and sold as two basic types: salts and esters. The most widely used salts are amines. The 2,4-D esters come in two forms, high-volatile and low-volatile esters. The low-volatile esters have slightly more killing power than the high-volatile esters, and they evaporate less at high temperatures (above 85° F.). Therefore the low-volatile esters are safer to use near sensitive crops.

MCP is a herbicide closely related to 2,4-D. It is less effective in controlling some weeds, but also less injurious to legume underseedings. Both MCP and 2,4-D may be applied in 10 or more gallons of water per acre. The amount of water does not affect results, provided the acid is applied properly at the correct rate. It is important, however, that the weeds be covered with the spray.

Randox (CDAA) is a grass-selective herbicide used as a pre-emergence treatment for the control of annual grasses such as giant foxtail (wild millet). Read directions on the container carefully before using this chemical; it is highly irritating to the skin, and goggles and gloves should be worn to prevent injury.

Safety Measures

Certain precautions are necessary in using herbicides. If they are handled carelessly, they may irritate your skin, cause crop damage, or affect the health of your livestock. To prevent hazardous effects, adopt the following practices.

Protect crops

1. Never spray fields next to susceptible crops or gardens on a windy day.

2. Do not use herbicides in growing crops unless weeds are serious enough to reduce crop yield or quality and cannot be eliminated economically by any other means. If the weed hazard is serious, use the proper selective herbicide.

3. Do not use pre-emergence treatment on sandy soils. Leaching is likely to occur and seed germination may be reduced.

4. Calibrate your spraying equipment often under conditions similar to those where spraying is to be done. If the application rate is altered by equipment, crops may be damaged by too much of the chemical, or effectiveness may be reduced because the application is inadequate.

5. Follow suggested rates, times, and methods for treatment as mistakes can cause crop yields to be seriously reduced. Suggested rates and methods given in this circular will not eliminate all hazards, but they are the safest known at present.

6. Follow the instructions given by the manufacturer on the herbicide container. The rates suggested in this circular are given in actual pounds of acid or active material per acre. But the chemical formulations may vary among different chemical companies, and you will have to follow directions on the container to see that the right amount of material, as it comes from the container, is applied per acre.

Protect livestock

1. MCP, 2,4-D, and 2,4,5-T are not poisonous to animals if used at recommended rates. However, some herbicides may be toxic to livestock. Before using a herbicide on pastures, read the container label to see whether or not it may have harmful effects.

2. Keep livestock out of pastures containing Jimson weed, white snakeroot, or other poisonous weeds that have been sprayed with 2,4-D, MCP, or 2,4,5-T. Such poisonous plants may be made more palatable to animals by these chemicals.

Protect yourself

1. When using herbicides, be careful to prevent them from coming into contact with your skin and eyes. Chemicals such as Randox, Dowpon, and TCA are caustic and may have irritating effects. When handling them, protect your eyes with goggles and wear rubber gloves.

2. Sodium chlorate, used as a spray, is highly flammable after it dries. Do not smoke while handling this chemical and remove clothing and shoes immediately after spraying if the spray has come into contact with them.

Adjusting Spraying Equipment

The success of any spray program depends largely on how well the spray materials are applied. The equipment must be properly adjusted and calibrated to deliver adequate amounts of material per acre uniformly.

Nozzle tips should be changed to meet the delivery requirements of each chemical. Volumes of sprays required for the most effective use of the chemicals applied vary with each chemical. Every piece of equipment must be calibrated separately and the amounts of material to be mixed with the carrier should be adjusted accordingly. Sprayers should be calibrated several times during the season, preferably before each spraying operation, so that corrections can be made to compensate for nozzle wear and different field conditions.

Do not calibrate sprayers on a hard road. Use soil conditions similar to those in the field to be sprayed and maintain a uniform field speed of 4 to 5 miles per hour. Any reduction in field speed will increase the delivery rate of the chemical applied if constant operating pressures are maintained. Where very small amounts of a chemical are needed, a reduction in field speed without corrections in calibration may allow the chemical to be applied at rates high enough to damage crops. Keep spray booms as low as possible to reduce wind drift, and maintain pressure at 30 to 40 pounds per square inch.

Following are simple methods to determine the amounts of liquid being delivered by sprayers:

Power sprayers (low-pressure, low-volume field sprayers)

1. Fill the tank with water and adjust the pressure to 30 to 40 pounds per square inch.

2. Spray 40 rods (660 feet) at 4 to 5 miles per hour in the field to

be sprayed or, if that is not practicable, in a similar field. Mark the throttle (governor) so that uniform speeds can be maintained later.

3. Refill the tank and measure the amount of liquid required for refilling.

4. Calculate the amount of liquid applied as follows:

$$\frac{\text{Number of gallons used} \times 66}{\text{Width of boom in feet}} = \text{gallons applied per acre.}$$

Example: If 3 gallons are used in 40 rods and the boom width is 20 feet, the spraying rate is 10 gallons per acre $\left(\frac{3 \times 66}{20} = \frac{198}{20}\right.$, or 10 gallons).

5. To determine the amount of chemical to be put in the tank, divide the number of gallons the tank will hold by the number of gallons the sprayer applies per acre. Multiply this figure, or the number of acres 1 tankful of liquid will cover, by the amount of chemical to be applied per acre.

Example: If the tank holds 55 gallons, and the sprayer applies 10 gallons per acre, 1 tank of spray will cover 5.5 acres ($55 \div 10 = 5.5$). If 2 pints (1 quart) of chemical are required per acre, then 11 pints are required per tankful ($2 \times 5.5 = 11$ pints, or 5½ quarts).

Hand (single-nozzle) sprayers

1. Mark off an area 10 by 10 feet (100 square feet).

2. Fill sprayer with water to the 3-gallon mark and spray the area using the same pressure and speed used for spraying weeds.

3. Refill sprayer, measuring accurately the amount of water required to refill to the original level.

4. Determine per-acre rate of spray delivery from the table below and add the required amount of chemical to the tank.

Nozzle discharge per 100 square feet	*Amount of spray delivered per acre*	*Amount of chemical to add to 3 gallons of liquid to apply 1 pint per acre of chemical*
½ pint	27 gallons	2 ounces[a]
1 pint	55 gallons	1 ounce
1½ pint	82 gallons	¾ ounce
1 quart	110 gallons	½ ounce

[a] 1 ounce = 2 tablespoons.

Weed Control in Farm Crops

Corn

The chemical weedkiller most commonly used in corn is 2,4-D. Other materials such as Randox, dinitro, and Sesone can also be used (see pre-emergence and post-emergence spraying below).

Pre-emergence sprays. These sprays are applied before the corn and weeds emerge to control the broad-leaved weeds and some annual grasses until the corn has a chance to get started. They are more effective if the soil is moist enough for the weed and grass seeds to germinate within 2 weeks after treatment.

Under the right moisture conditions, the ester type of 2,4-D will effectively control some annual grasses and broad-leaved weeds on most soils. *This treatment should not be used on light or sandy soils.* Use no more than 2 pounds of 2,4-D acid per acre. Application can be made any time from planting until the corn comes through the ground, *but not after the leaves unfold.* Spraying 3 to 5 days after the corn is planted gives best control. Only the ester type is suggested for pre-emergence sprays.

Randox, a grass-selective herbicide, applied at the broadcast rate of 4 pounds of acid (4 quarts) in at least 20 gallons of water per acre will control most annual grasses such as giant foxtail (wild millet), barnyard grass, green and yellow foxtail, and cheat in corn. *It should not be used on sandy soils.* You may control both grasses and broad-leaved weeds with a mixture of 3 pounds (3 quarts) of Randox acid and 1 pound of ester 2,4-D acid in 20 gallons of water per acre. Randox can be sprayed directly over the planted row in 10- to 12-inch bands, using only 1 pound of acid (1 quart) and 5 gallons of water per acre. (This method allows more acres to be sprayed per gallon of material.) Wear rubber gloves and goggles for protection when handling Randox.

Like other pre-emergence chemicals, Randox is most effective if there is enough soil moisture to cause germination of the grass seeds. Early cultivation of corn should be avoided unless absolutely necessary for maximum effectiveness of the pre-emergence treatment.

Dinitro (DNBP) applied at the rate of 8 to 10 pounds of active ingredient per acre can be used as a pre-emergence treatment before the corn comes through the soil. Like 2,4-D, it is effective only if there is enough soil moisture to cause immediate germination of the weed and grass seeds.

Sesone (Crag Herbicide-I), a material similar to 2,4-D, is also suggested if the soil is *not* light or sandy. It should be used at the rate of 4 pounds per acre.

Post-emergence sprays, which are made after the weeds and corn start to come up, are effective only on susceptible broad-leaved weeds. They do not affect annual grasses. These sprays are suggested only if the weed problem cannot be controlled by normal cultivation, as they can injure growing corn. If you do spray growing corn, danger of injury can be kept at a minimum by using nozzle extensions to confine the spray to the soil and base of the plant, and by applying the proper rates. Corn should not be sprayed with 2,4-D from the time it starts to tassel until after the kernels are in the soft dough stage.

Stalk brittleness can result from spraying with 2,4-D. It is most likely to occur when spraying is done after periods of high daytime temperatures (85° to 90° F. and over), and is usually most serious when the corn is growing rapidly. If a storm or cultivation occurs before brittleness disappears, it can cause serious stalk breakage. Until the corn is 3 or 4 feet tall, apply no more than ¼ pound of the ester form of 2,4-D or ½ pound of the amine form per acre. After the corn has reached that height, rates may be increased if the proper nozzle extensions are used, and the spray is kept off as much of the plant as possible.

If you expect a dense growth of weeds after the last cultivation, you can follow it with an application of 1 pound of 2,4-D acid — *provided* you apply directly to the soil and use a boom extension.

A light application of dinitro can be used to control annual grasses such as giant foxtail. Timing of the application is quite important — the material should be applied just as the grasses are emerging from the soil. Dinitro is least injurious to corn in the spike stage — at this time 3 to 5 pounds of active ingredient per acre will cause no injury. After the corn leaves unfold, do not use more than 3 pounds per acre; even this may result in slight burning of the leaves, but the burning will disappear after several days.

Special weed problems in corn. *Wild sweet potato* in cornfields can be killed by applying ¼ pound of ester or ½ pound of amine 2,4-D acid per acre at the bud stage — usually in late July or early August. Use high-clearance equipment or a knapsack sprayer. Applications made either before or after the bud stage will kill the top growth but will not usually affect the root system.

Wild cucumber is resistant to 2,4-D but susceptible to 2,4,5-T. To control this weed, apply ¼ pound of 2,4,5-T acid per acre any time before the cucumbers start to bloom. This material has about the same effect on corn as 2,4-D.

Sorghums

Randox broadcast as a pre-emergence spray at the rate of 4 pounds of acid (4 quarts) in at least 20 gallons of water per acre, or placed in a 10-inch band over the planted row using only 1 pound of acid (1 quart) and 5 gallons of water per acre, will control most annual grasses including giant foxtail. The tolerance of sorghums to Randox is like that of corn. Apply Randox on sorghum just as it is applied on corn or soybeans; do not use it on sandy soils, and wear goggles and gloves for protection.

The use of 2,4-D is suggested only as an emergency measure to control weeds in sorghums. It should be applied, post-emergence, at the lowest rates practicable, not more than ¼ pound of the ester type or ½ pound of the amine type per acre. Sorghums are most tolerant to 2,4-D in the 4- to 12-inch stage of growth. The same spray precautions used for weed control in corn apply to the use of 2,4-D in sorghums.

Soybeans

Soybeans are much more susceptible to severe injury from herbicides than are most other crops. Therefore weeds in soybeans should be controlled with good cultural practices if at all possible. The most effective method is to prepare the seedbed early and destroy one or more crops of weeds before the beans are planted.

If previous experience indicates that cultivation will not control weeds and that yields may be severely reduced as a result, then you might try the following suggestions for pre-emergence and post-emergence spraying. It is essential, however, to follow suggested rates, methods, and timing exactly. Otherwise, severe injury may result to your crop.

Pre-emergence sprays. Randox, Chloro IPC, dinitro, and Alanap are available for pre-emergence treatments of soybeans; they must be applied before the beans come up. *These materials should not be used on sandy soils.* For the best results, spray at the same time as planting, or within two or three days at the most; otherwise rains may prevent effective applications. The material can be applied by mounting a sprayer on the planter, allowing the spray to fall behind the planter wheels.

Randox, a grass herbicide, broadcast at the rate of 4 pounds of acid (4 quarts) in 20 gallons of water per acre will control most annual grasses such as giant foxtail. For band-placing directly over the planted row, use 1 pound of acid (1 quart) and 5 gallons of water per acre.

Chloro IPC, Alanap, and dinitro are effective on most broad-leaved weeds; dinitro is less effective than the others in controlling grasses. Apply 6 to 8 pounds of Chloro IPC or 4 to 6 pounds of Alanap in 20 gallons of water per acre; or use 6 to 8 pounds of dinitro in 20 to 30 gallons. (The low rates should be used on light soils; the higher rates are for heavy soils, or those with high clay content.) At these rates soybean stands may be reduced somewhat, but usually not enough to affect yields. These chemicals may also be band-placed using much less material and water per acre. If you get good weed control with band treatment, avoid introducing new weed seeds into the area by cultivation. Chloro IPC, Alanap, and dinitro at the suggested rates will not completely control giant foxtail or some of the other annual grasses. Ten pounds per acre would normally be effective, but soybeans will not tolerate such a high rate.

It is suggested that pre-emergence spraying be tried out in small areas for a year or two before it is attempted on a large scale. Effectiveness of treatment with Randox, Chloro IPC, dinitro, or Alanap depends largely on weather and soil conditions. If the soil is moist enough to insure prompt germination of the weed seeds, the results should be good. But if the soil stays dry for 2 or 3 weeks after treatment, the chemical may decompose or lose some of its strength before the weeds germinate. These materials must come into contact with the weed in order to destroy it. If the seedbed is rough or cloddy, the treatment will be less effective. You will get better results if the seedbed can be rolled before treatment.

Post-emergence sprays. Experiments and experiences of farmers indicate that 2,4-D can be used at extremely light rates to control certain weeds in soybeans. Two ounces of the amine type of acid, *applied when the soybeans are 2 to 6 inches tall,* will control cocklebur, ragweed, pigweed, and annual morning glories without damaging the crop. Velvetweed, Jimson weed, and smartweed are not always killed at this rate, but are usually stunted so that cultivation destroys many of them. This treatment is primarily designed for river-bottom areas or other areas where broad-leaved weeds are a major problem. If you use it, try spraying just a few acres for a year or more so that you can observe results and become more proficient in applying light rates.

Small grains

Two chemicals — 2,4-D and MCP, which are closely related — are suggested for controlling broad-leaved weeds in small grains. They should not be used where there are legume underseedings unless the

weed hazard is serious, because they may damage the legumes. Sweet clover is particularly sensitive to these chemicals; *it should not be sprayed with 2,4-D.* MCP is less injurious to legumes, but 2,4-D is more effective for the control of certain weeds.

Spring oats, barley, and wheat. Apply the amine type of 2,4-D or MCP. If there is no legume underseeding, as much as ½ pound of acid per acre may be applied, although this may reduce grain yields somewhat. Where there are legumes such as alfalfa, red clover, ladino clover, alsike clover, birdsfoot trefoil, and lespedeza, no more than ¼ pound should be used. Apply after the grain has passed the five-leaf stage and before it is in the boot stage.

If the grain contains only small areas of Canada thistle, field bindweed, or other noxious weeds, spot treatments at the rate of ½ to 1 pound of acid per acre are suggested. Although this rate will destroy the legume underseeding and probably reduce grain yield in the treated area, this disadvantage may not be objectionable if the area is small.

Winter wheat. In general, winter wheat tolerates 2,4-D better than most spring grains. It should not, however, be sprayed with 2,4-D in the fall.

Where legumes have been seeded with the wheat, ¼ pound of amine 2,4-D acid per acre is the maximum amount to use. This rate will usually control most troublesome weeds except wild onion and garlic. Spray after the wheat has finished stooling in the spring and before it is in the boot stage. April is usually the proper time.

To control wild onion and garlic, use ½ to ¾ pound of ester or amine. This amount may slightly reduce the wheat yield, and it will probably destroy legume underseedings. Even this heavy rate will kill only 30 to 50 percent of the wild garlic, but the remaining plants will usually be so distorted that the combine will miss them if the wheat is not lodged.

Control of Specific Weeds

Canada thistle

2,4-D has proved a good weapon against some strains of Canada thistle; it is cheap, easy to apply, and can be used in some crops, but some strains are entirely resistant to 2,4-D and they may occur in the same patch or field as susceptible strains.

Amino triazole, a new chemical, appears to be very effective in killing most strains of Canada thistle. Research results indicate that it gives a high degree of elimination when 4 to 6 pounds of active

material in 30 to 40 gallons of water are applied on thistles at the pre-bud stage of maturity, preferably about 8 to 12 inches tall. If the thistles are mature before treatment, clip them and treat the regrowth when it is 6 inches tall. However, amino triazole is toxic to other crops and should not be broadcast over pastures or cultivated fields; its use is limited, at present, to spot-treatment for thistles on non-crop land.

Amino triazole was also tested as a pre-planting treatment for fields planted to corn or soybeans that were infested with Canada thistle. Four to 6 pounds of active material were broadcast in 20 gallons of water per acre early in the spring when the thistles were from 6 to 10 inches tall. Two weeks later the areas were plowed or disked, the seedbed prepared, and the crop planted. This treatment substantially reduced the thistle stands.

Spot treatments with 2,4-D can be used in some crops for effective control of susceptible strains of Canada thistle. The suggested rate is ½ to 1 pound of acid per acre. It should be applied 2 or 3 times a season — at the pre-bud stage and again whenever regrowth occurs. More than 1 pound per acre is usually less effective because heavy rates cause a rapid top-kill and less of the 2,4-D penetrates to the roots. A slow top-kill is more desirable for effective root destruction. Continue the pre-bud and late summer treatments for two or more years.

If the thistles are located in a growing crop and spot treatment is not practicable, use a lower rate of application, depending on the crop. Apply the material at a time when it will do the least harm to the crop, even though this may mean poorer weed control. At present, if you are dealing with a resistant strain in a crop, you will need to make a spot treatment of sodium chlorate or Atlacide, or follow a system of clean cultivation in order to complete the job.

One cultural method that has proved effective in controlling Canada thistle is to plow under the weed when budding starts and follow with a field cultivator every 2 or 3 weeks until fall or until winter wheat or rye is planted. After the crop is harvested the following year, the process should be repeated. Following this practice for 2 or 3 years should eliminate most of the thistles.

Wild garlic

Wild garlic is not easy to control. The two best methods are winter plowing and spraying with 2,4-D. Because this weed forms new under-

ground bulbs during March or April, it is important to spray at that time or earlier. Best results have been obtained by using 2 to 3 pounds of 2,4-D acid of the ester type per acre during October, November, February, March, or April. An application this heavy cannot be used on crops, but it can be used on soybean stubble, cornstalk land, or grass pasture. If you don't spray until February or later, leave the land undisturbed as long as possible, and don't plow for corn or soybeans until at least 3 or 4 weeks after spraying. For adequate control, this procedure should be repeated for 2 or 3 successive years.

Spraying garlic in growing wheat has been discussed under "Winter wheat" (page 13).

Quackgrass

Dowpon, a new chemical, is suggested for controlling quackgrass. At heavy rates — 20 to 30 pounds per acre — Dowpon will sterilize the soil, but the effect lasts less than a year. At light rates — 6 to 8 pounds an acre — its effects disappear in 3 or 4 weeks and so it can be used on cropland. Sodium chlorate and borax also control quackgrass, but they sterilize the soil for two or more years. They are suggested only for spot treatment on small patches of quackgrass.

Dowpon is absorbed through the quackgrass foliage and must be applied in sufficient water to thoroughly wet it. It is somewhat caustic and eyes and skin should be protected from contact with this chemical.

Crop areas. In the spring quackgrass can be treated when it is 6 to 10 inches tall by spraying 6 to 8 pounds of Dowpon in 30 to 40 gallons of water per acre on the foliage. Plow down the treated area 6 to 8 days after treatment. Wait 3 to 4 weeks; then prepare the seedbed for planting corn or soybeans.

In the fall Dowpon can be applied at higher rates, and under most conditions can be followed by a crop of corn or beans in the spring. Plow or disk quackgrass in late summer, and during September or October apply 20 to 30 pounds of Dowpon to the existing foliage in 40 to 50 gallons of water per acre.

Fence rows and non-crop areas. Apply 10 pounds of Dowpon acid per acre to the quackgrass while it is growing rapidly and before heading. Use 30 to 40 gallons of water per acre or enough to completely cover the foliage. If regrowth appears, apply a second application of 6 to 8 pounds of Dowpon acid in 20 to 30 gallons of water per acre.

Johnsongrass

Dowpon and TCA are suggested for controlling Johnsongrass on cropland. When applied at heavy rates they sterilize the soil, but the effects of the chemical usually last less than a year. Atlacide or sodium chlorate, and borax will also control this grass but they sterilize the soil for a period of two years or more and are not recommended for cropland except for spot treatments.

Dowpon and TCA are fairly expensive for large-scale operations. They are, however, practical and efficient on a small scale except during long periods of dry weather. There must be enough rainfall to wash the chemicals into the soil around the roots of the grass. Dowpon seems to be absorbed through the foliage more readily than TCA. Both chemicals are somewhat caustic and should not come into contact with the skin or eyes.

In cropland where dense stands of Johnsongrass appear after harvest, spray during August or September. Apply 20 to 30 pounds of Dowpon or 60 to 80 pounds of TCA acid per acre in sufficient water to thoroughly cover the foliage. Fall plow if possible. This application can be followed by a crop of corn the following spring. Dowpon sprays for small areas can be mixed at the rate of ¼ pound of Dowpon per gallon of water and applied at the rate of ½ gallon of solution per square rod. Apply TCA to small areas at the rate of ⅓ to ½ pound per square rod. A spray solution should be made of ⅓ to ½ pound of TCA per gallon of water and applied at the rate of 1 gallon of the prepared solution per square rod.

Foliage applications of Dowpon made in the summer while Johnsongrass is in its most active growing state will in most cases reduce stands and prevent seed formation. Apply 20 to 30 pounds of acid per acre in sufficient water for complete coverage before the Johnsongrass heads. Stands of new seedlings may be reduced in many areas by applications of 4 to 5 pounds of Dowpon in at least 30 to 40 gallons of water per acre.

Atlacide, a soil sterilant, should be applied to clumps of Johnsongrass as soon as they are found at the rate of 6 to 7 pounds per square rod. Many times 1 or 2 handfuls of the dry material placed around the clump will prevent the grass from spreading.

In areas that are not subject to floods in winter or early spring, Johnsongrass can be kept under practical control by starting clean cultivation in June or July after winter wheat or barley has been

harvested. The area should be kept free of the weed until September or October, when winter wheat or barley is planted again. Heavy pasturing or frequent clipping, or a combination of the two, will also reduce stands of Johnsongrass.

Forage Crops

Herbicides should be applied to forage crop mixtures only if the crop is seriously infested with weeds that threaten its loss.

Seedling grass-legume mixtures

To control seedling broad-leaved weeds, apply ¾ to 1½ pounds of the amine salt of dinitro in 20 to 40 gallons of water per acre. This treatment may be applied without seriously injuring grasses or legumes except birdsfoot trefoil. Apply during periods of low temperature and humidity.

Research results have indicated that Dowpon may aid the establishment of birdsfoot trefoil seedlings when applied either pre- or post-emergence at the rate of 2 to 4 pounds of acid in 20 to 30 gallons of water per acre. It has usually eliminated most grass competition while the trefoil seedlings are small, and has encouraged a faster and more uniform establishment of the pure seedings. Dowpon should not be used for establishing seedlings of other legumes, such as alfalfa and the clovers; these legumes apparently do not have sufficient tolerance to Dowpon.

Established grass-legume mixtures

MCP or the amine form of 2,4-D may be used at light rates in legumes such as alfalfa, red clover, ladino clover, alsike clover, birdsfoot trefoil, and lespedeza. Legumes are very sensitive to 2,4-D, so only the amine form should be used. To avoid serious damage apply ⅛ to ¼ pound in 5 to 20 gallons of water per acre in the spring while the legumes are in the early dormant state, or immediately after hay harvest. *Do not spray sweet clover with 2,4-D.* This treatment will control sensitive broad-leaved weeds but it will not affect grasses.

Dinitro can also be used to control henbit and yellow rocket. Apply 1 to 2 pounds of the amine salt of dinitro in 20 to 40 gallons of water per acre in the fall when the legumes are dormant and the weeds are small. A second application may be necessary in the late winter or early spring if the infestation is very heavy.

Fence Row Spraying

If the vegetation in fence rows consists primarily of weeds, use 2,4-D at the rate of ½ to 1 pound of acid per acre. The first application should be made early, probably in May, to control early weeds, and another application should be made in July or early August to control late weeds.

If the fence row vegetation consists chiefly of woody plants, use a mixture of 2,4-D and 2,4,5-T as described below.

Control of Woody Plants

Both 2,4-D and 2,4,5-T are useful for the control of woody plants. Foliage sprays of 2,4-D will kill some plants that 2,4,5-T won't kill, and vice versa. Therefore mixtures of 2,4-D and 2,4,5-T are recommended for general foliage spraying of mixed brush. For basal bark applications, 2,4,5-T in oil is preferable.

Foliage sprays of 2,4-D and 2,4,5-T are most effective on woody plants less than 15 feet tall. For larger plants, it is better to use the basal or stump treatment described below.

If woody plants are sensitive to either 2,4-D or 2,4,5-T, spray the foliage with 3 to 4 pounds of acid per 100 gallons of water during the period from full leaf in the spring until about the last of August. Except for buckbrush, use a mixture of 2,4-D and 2,4,5-T; to kill buckbrush, 2,4-D alone will be more effective. Ester formulations will usually be most satisfactory; water is usually preferable to oil as the carrier.

Drift is always a hazard to adjacent susceptible crops. If soybeans, legumes, or other sensitive crops are located nearby, a low-volatile ester should be used and spraying should be done on days when there is no wind. Use the amine sprays where there is an extreme danger of damaging crops or other property.

Basal bark sprays will control larger woody plants and also several species, including some oaks and maples, that are tolerant to foliage sprays. A 2-percent solution of 2,4,5-T in oil, such as kerosene, is recommended. This will be ½ pound of acid in 3 gallons of oil or 16 pounds in 100 gallons.

Spray the base of the trunk from the ground to a height of 15 inches. Circle the trunk completely, and spray until the soil immediately at the base of the tree is wet from the runoff. The spray can be

applied at any time of year, but best results are obtained from spraying between December 15 and March 15.

Trees larger than 8 inches in diameter may be killed more effectively by cutting frills in the bark at a height of 2 to 3 feet and applying the material in the frills. The mixture can be applied in the frills with an ordinary oil can.

Stump treatments. If woody plants are removed by cutting, 2,4-D, 2,4,5-T, or Ammate applied to the freshly cut stump will keep most species from sprouting. The preferred treatment is ½ pound of 2,4,5-T acid, ester type, in 3 gallons of oil, such as kerosene or fuel oil. Circle the stump with the spray, and apply until there is runoff. A mixture of 2,4-D and 2,4,5-T can also be used, but at a heavier concentration. Stump treatments can be made at any time of year. Some shrubs and trees that tolerate foilage sprays can be killed by this method.

Ammate applied as a dry salt (1 tablespoon per 2 inches of diameter) or a concentrated water solution (6 to 9 pounds per gallon of water) also prevents woody plants of most species from sprouting.

Herbicides Discussed in This Publication

Common or brand name	Chemical name	Rates per acre expressed as
Alanap	sodium N-1 naphthyl phthalamate	acid equivalent
Amino triazole (ATA)	3-amino-1,2,4-triazole	active ATA
Ammate	ammonium sulfate	active Ammate
Atlacide	(preparation of sodium chlorate)	100% Atlacide
Borax	borax	100% borax
Boron-chlorate	boron-chlorate	100% boron-chlorate
Chloro IPC	isopropyl N-(3-chloro-phenyl) carbamate	100% CIPC
Dinitro (DNBP)	4,6-dinitro ortho secondary butylphenol	DNBP equivalent
Diuron (DCMU)	3-(3,4-dichlorophenyl)-1, 1-dimethylurea	100% Diuron
Dowpon	2,2-dichloroproprionic acid	acid equivalent
Fenuron (PDU)	3-(phenyl)-1,1-dimethylurea	100% Fenuron
MCP	2-methyl-4-chloro-phenoxyacetic acid	acid equivalent
Monuron (CMU)	3-(p-chlorophenyl)-1, 1-dimethylurea	100% Monuron
Randox (CDAA)	alpha-chloro-N,N-diallylacetamide	acid equivalent
Sesone (CRAG I)	sodium,2,4-dichloro-phenoxyethyl sulfate	active Sesone
Sodium chlorate	sodium chlorate	100% sodium chlorate
TCA	trichloroacetic acid	acid equivalent
2,4-D	2,4-dichlorophenoxyacetic acid	acid equivalent
2,4,5-T	2,4,5-trichlorophenoxy-acetic acid	acid equivalent

20M—4-57—62157